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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/819,762	03/29/2001	Yoshiki Sakuma	010401	2685

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EXAMINER

BAUMEISTER, BRADLEY W

ART UNIT PAPER NUMBER

2815

DATE MAILED: 12/17/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/819,762

Applicant(s)

Sakuma et al.

Examiner

B. William Baumeister

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.138 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on Sep 23, 2003.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-8 and 11-18 is/are pending in the application.
- 4a) Of the above, claim(s) 3 and 12-18 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1, 2, 4-8, and 11 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claims _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
*See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s). _____ 6) ☐ Other: _____

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DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

2. Claims 1, 2, 4-8 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's prior art admissions in view of Furukawa '614 and Croke, III '795.

a. Applicant acknowledges in the Background section of the specification that it was known to provide an HBT having a Si collector, a graded SiGe base, and a Si emitter (see e.g., FIG 1B). Applicant also acknowledges as conventional that the purpose of increasing the base's Ge content towards the collector in this manner was to progressively decrease the bandgap and thereby increase the carrier diffusion and drift across the base region. Applicant further acknowledges that it was known that the Ge grading caused lattice misfit dislocation problems, that the boron dopant diffusion from the base was also a problem, and that various attempts had been made to address these problems. Applicant does not acknowledge that it was known how to alloy the SiGe base layer with carbon to overcome the lattice misfit problems, nor that it was known to employ SiC interface layers to overcome the boron diffusion problem.

b. Furukawa '614 teaches that C can be added to SiGe in a Ge:C constant-ratio range of about 6.7/1 to 12/1 (e.g., claim 1) for Si concentrations ranging from about 90% to 0 % (e.g., col. 7, lines 50-54) for the purpose of reducing the lattice strain between SiGe/Si heterointerfaces

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and thereby inhibiting resultant lattice defects. Furukawa specifically teaches that this concept may be employed for Group IV HBTs formed on a Si substrate having a SiGeC base and that the resultant base bandgap is smaller than that of the Si emitter and collector (e.g., col. 5 and FIG 4). Furukawa does not teach grading the Ge content of the SiGeC base.

c. It would have been obvious to one of ordinary skill in the art at the time of the invention to have added C to the SiGe base region of Applicant's Prior-Art FIG 1 in a corresponding C:Ge ratio as taught by Furukawa for the purpose of reducing the device's lattice strain and increasing the degree of design freedom in adjusting the various region's bandgaps as desired.

d. Regarding the newly added limitation of the SiC interface layer, Croke teaches that Si-based HBTs with Si collector and emitter regions and a SiGe base region possessed the problem of boron diffusing from the base. Croke teaches that this boron diffusion problem can be reduced or eliminated by incorporating a SiC layer within the emitter towards the E-B junction. FIG 2 depicts a further Si layer 206 being interposed between the SiGe base 202 and the SiC layer 208. It is somewhat unclear whether the post-growth annealing step will cause the boron to diffuse throughout the lower Si layer 206 (and thereby convert it into a further portion of the base region). If so, after the anneal the SiC region 208 would form an interface layer between the emitter and base. Alternatively, even assuming *arguendo* that boron diffusion does not occur to such an extent that region 206 becomes part of the base region, Croke further states that as an alternative to placing the SiC layer outside of the emitter-base depletion region, the SiC layer may

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also be placed either within the depletion region or so as to overlap the base-emitter depletion region (col. 5, lines 11-23). As such, Croke teaches that the SiC layer may be formed at an interface between the emitter and the base according to claim 1.

e. It would have been obvious to one of ordinary skill in the art at the time of the invention to have further employed within a Si-emitter/graded-SiGeC-base/Si-collector HBT according to Applicant's prior art and Furukawa, a SiC interface layer at the E-B junction for the purpose of reducing or eliminating boron diffusion from the base as taught by Croke.

f. In further regard to claim 11 which sets forth a second SiC interface layer at the base-collector interface, in addition to expressly disclosing a SiC layer at the emitter-base junction, Croke further teaches that boron diffusion towards the collector was also a concern. See e.g., Croke's prior-art FIG 1A wherein undoped SiGe spacers 102 were employed on both sides of the base to prevent boron diffusion. As such, it would have also been obvious to the skilled artisan to have further provided a second SiC layer at the base-collector junction for the purpose of preventing boron diffusion at this junction as well.

Response to Arguments

3. Applicant's arguments filed 9/23//2003 have been fully considered but they are moot in light of the new grounds of rejection.

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Conclusion

4. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

- a. Morishita '398
- b. Hashimoto '118
- c. Casady et al. '396

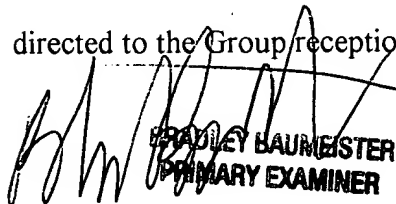
5. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

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INFORMATION ON HOW TO CONTACT THE USPTO

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to the examiner, **B. William Baumeister**, at **(703) 306-9165**. The examiner can normally be reached Monday through Friday, 8:30 a.m. to 5:00 p.m. If the Examiner is not available, the Examiner's supervisor, Mr. Tom Thomas, can be reached at (703) 308-2772. Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group/receptionist whose telephone number is (703) 308-0956.



BRADLEY BAUMEISTER
PRIMARY EXAMINER

B. William Baumeister

Primary Examiner, Art Unit 2815

December 13, 2003